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14. ABSTRACT

Network Centric Warfare development is currently proceeding from the tactical level up, with little concern to the overarching requirements of the operational level of war. The implied assumption is that the concepts, both technical and organizational, will naturally scale to the operational and strategic levels. Absent an operational perspective, what is likely to develop is a large-scale tactical tool set and an operational staff structure that evolves to support this tactical tool set. This paper examines Network Centric Warfare from the Operational Commander's perspective by first examining the Operational Commander's requirements of a command and control system, comparing those requirements to what Network Centric Warfare as currently envisioned will provide, then recommends an operational staff organization to support the requirements of the Operational Commander in a Network Centric Warfare environment. The recommended staff structure is designed to provide the Operational Commander the flexibility to benefit from self-synchronized forces as well as to take close control of forces when required by the mission.

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NETWORK CENTRIC WARFARE: AN OPERATIONAL PERSPECTIVE

By

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A paper submitted to the faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

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09 February 2003

Abstract

Network Centric Warfare development is currently proceeding from the tactical level up, with little concern to the overarching requirements of the operational level of war. The implied assumption is that the concepts, both technical and organizational, will naturally scale to the operational and strategic levels. Absent an operational perspective, what is likely to develop is a large-scale tactical tool set and an operational staff structure that evolves to support this tactical tool set. This paper examines Network Centric Warfare from the Operational Commander's perspective by first examining the Operational Commander's requirements of a command and control system, comparing those requirements to what Network Centric Warfare as currently envisioned will provide, then recommends an operational staff organization to support the requirements of the Operational Commander in a Network Centric Warfare environment. The recommended staff structure is designed to provide the Operational Commander the flexibility to benefit from self-synchronized forces as well as to take close control of forces when required by the mission.

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Introduction.

> *New technologies [will] not lead to the collapse of the levels of war… As history has shown that strategy and tactics cannot be bridged by bypassing the Operational level of war.*[1]
>
> Professor Milan Vego

Former War College President VADM Arthur K. Cebrowski has said that Network Centric Warfare (NCW)[2] applies across all levels of warfare.[3] However, an examination of the current state of NCW technologies reveals that technological development is progressing exclusively from the bottom up, and therefore has a distinctly tactical flavor. Moreover, discussion of organizational change is lagging that of technological change. Absent an overarching development program emphasizing strategic and operational requirements, the implicit assumption is that technological developments at the tactical level will naturally scale to the operational and, presumably, strategic levels.

The thesis of this paper is that current Network Centric Warfare concepts do not fully support the requirements of the Operational Commander. In addition to technological development, staff organizations must evolve to support the Operational Commander in a network centric environment.

To examine this thesis, this paper will first analyze the current state of NCW concept and technology development. It will then examine the warfighting requirements of the Operational Commander, with an emphasis on information and command and control requirements. A comparison of the Operational Commanders' requirements and the current state of NCW concept and technology development will reveal requirements that are not being adequately addressed. Finally, the paper will make recommendations, both organizational and technical, for development of Network Centric systems to support the

Operational Commander. It is hoped that this paper will provide a starting point for discussion on the development of Network Centric Warfare staff organization.

Network Centric Warfare Today.

> *We define Network Centric Warfare as an information superiority-enabled concept of operations that generates increased combat power by networking sensors, decision-makers, and shooters to achieve shared awareness, increased speed of command, higher tempo of operations, greater lethality, increased survivability, and a degree of self-synchronization.*[4]
>
> Alberts, Garstka, and Stein

There are currently two competing concepts for netted warfare, although both have been referred to as Network Centric Warfare. In the vision articulated by ADM William A. Owens USN (Ret), low-level, tactical systems communicate through an information grid, with the result being an amalgamated picture of the battlespace. This gives higher echelon commanders total visibility of the battlespace and the ability to control forces to accomplish the mission. In the competing vision, articulated by VADM Arthur Cebrowski, USN (Ret), tactical forces contribute to a common operational picture (COP) and are in turn recipients of the COP. Because all forces have the same battlespace awareness, tactical units are able to self-synchronize to accomplish the commander's intent.[5]

There is a large volume of writing regarding the strengths and weaknesses of each model. The chief criticism of the Owens approach is that it may lead to the micro-management of forces by operational and even strategic level commanders, stifling the spirit of tactical innovation that has historically been a strength of the armed forces. Supporting the Owens vision is recent experience, in which tactical actions have had an increasing impact on the operational and strategic levels. Furthermore, tactical personnel lack the training and experience to account for operational and strategic considerations, requiring more careful management of tactical consequences by higher echelon commanders. These factors argue

for a degree of close control of tactical action to ensure the consequences are properly managed. This argument in support of the Owens vision is the chief criticism of the Cebrowski vision; namely that self-synchronized tactical forces lack the experience to understand the possible operational and strategic impact of their self-synchronized efforts.

Perhaps the defining description of NCW to date is Alberts, Garstka, and Stein's *Network Centric Warfare: Developing and Leveraging Network Superiority*. While leaning significantly toward the Cebrowski vision, this work does an excellent job of outlining a concept and set of requirements more toward the center of the debate. Alberts correctly concludes that NCW will not change the fundamental nature of warfare.[6] He states that the focus is on information flow and sharing, not on the network itself; the network allows, but doesn't require, forces to operate "in a linked fashion."[7] It will provide the "capability to generate shared awareness with increased quality."[8] The end result is a higher probability of the decision-maker having access to the right information at the right time to take action. Alberts argues that this will enable self-synchronization because the netted tactical commander will have better situational awareness than the operational commander today.[9] In turn, self-synchronization will "lock-in" success and "lock-out" enemy options.[10] Alberts' view recognizes the goal of self-synchronization while acknowledging it is not always required–centralized control is sometimes necessary.

There has been little effort to define what NCW means in operational or strategic terms. Current systems, both fielded and experimental, being touted as Network Centric are all tactical in nature. Systems such as the Army's Blue Force Tracker (BFT), the Navy's Cooperative Engagement Concept (CEC), Global Command and Control System (GCCS),

and the Knowledge-Web (K-WEB) deployed with the last several Carrier Strike Groups, are evolutionary efforts to improve existing technologies or fill specific tactical needs.[11]

Theoretic development of NCW concepts has proceeded from two viewpoints which represent different approaches to operational art–command by influence (Cebrowski, Alberts) and command by direction (Owens). The implementation of NCW is currently proceeding from the tactical perspective. The implied assumption is that the aggregation of tactical systems will yield an operational system. The evidence available suggests that what will actually obtain, absent an operational perspective, is a very large scale tactical tool set and a staff organization designed to meet the requirements of such a tool set. New organizational structures need to be developed to leverage the emerging technology.

The Operational Commander.

> *At the operational level, anticipation and synchronization, not supervision of ongoing actions, give commanders their most profound effect on success…*
>
> John R. Ballard[12]

The role of the Operational Commander is to translate strategic objectives into tactical engagements which, when properly sequenced and synchronized, produce a military end state. He accomplishes this through two main endeavors: planning and execution.

Joint Pub 3-0 outlines five questions the Commander should use as a guide:[13]

i. What **military conditions** must be produced in the operational area to achieve the strategic goal? (Ends)
ii. What **sequence of actions** is most likely to produce that condition? (Ways)
iii. How should the **resources** of the joint force be applied to accomplish that sequence of actions? (means)
iv. What is the likely **cost or risk** to the joint force in performing that sequence of actions?
v. What resources must be committed or actions performed to successfully execute the JFC's exit strategy? [Emphasis in original]

The questions above apply to both planning and execution, although the relative emphasis on each will necessarily shift as the commander and staff move from planning to execution. The five questions have an important common thread–the requirement to project a current situation into the future and from that projection, to evaluate alternative courses of action (COAs). This is the first of the Operational Commander's requirements: The Commander requires tools and a staff organization that are optimized for projecting the current (or planned) situation into the future and analytically evaluating alternative COAs.

There is a large body of research on the characteristics of successful commanders.[14] A review of the literature suggests the conclusion that command by influence is the most likely method to be successful.[15] This implies a degree a self-synchronization of forces, absent specific direction from higher authority. It also implies a degree of control, especially if events occur that invalidate the commander's image, and thus require adjustments. These two implications have a significant impact on what NCW should provide the commander. As technology improves the amount of information available to the commander, the key skill remains the ability to recognize when information confirms or, more importantly, contradicts the command concept.[16] Although research suggests that command by influence is the most successful method, the styles of commanders vary according to their personalities and experience. Accordingly, the Operational Commander requires a staff organization and tools that are flexible enough to accommodate different styles of command.

Commanders' Information Needs.

> *… the native mode of command is an image, or mental model, not voice or text.*[17]
>
> Thomas J. Czerwinski

In order to standardize terminology, this paper will use a hierarchy of information terms. At the bottom of the hierarchy is *data*, which is information without context.

Examples of data include a latitude, a longitude, an altitude, a number, or a size. A piece of data with context is *information*. Examples are the number of infantry battalions in an AOR, the position of an aircraft, or the amount of ordnance remaining in a tank. Information that has been assimilated into the commander's mental image is *knowledge*. The conversion of data to information to knowledge requires, at each step, some amount of processing. This processing may be as simple as a display, or as complex as intelligence analysis. It may require human analysis, or it may be accomplished by automated means. Further, conversion from data to information may generate a requirement for more data, and conversion from information to knowledge may lead to requirements for more information. See Figure 1.

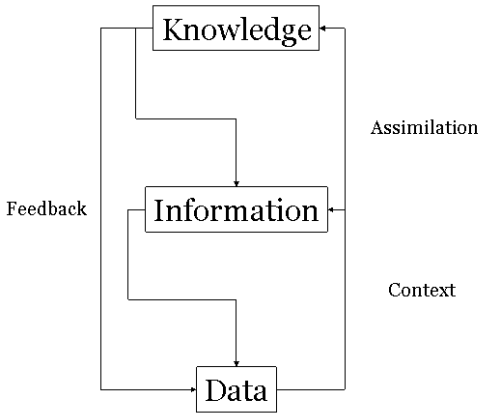

Figure 1: Hierarchy of Information

These feedback loops are an important part of building the commander's mental image.[18] Figure 2 is a simplified illustration of how various staff and subordinate elements each contribute to the commander's image.

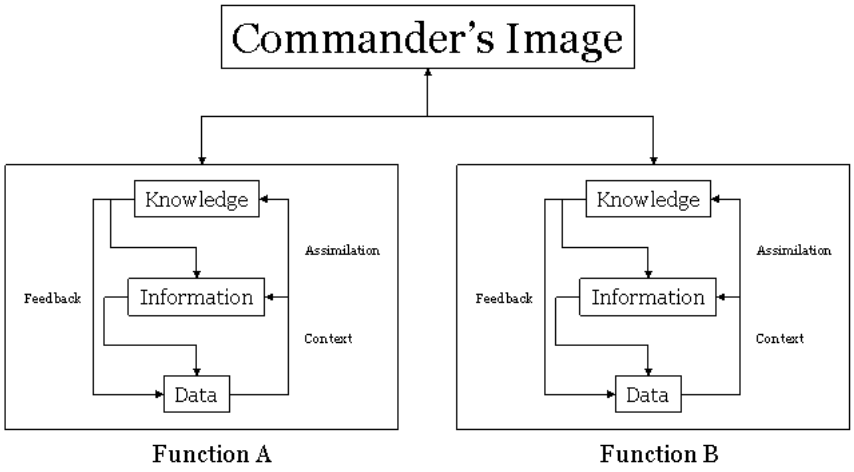

Figure 2: Maintenance of the Commander's Image

In their authoritative study of the commander's information needs, Kahan, Worley, and Stasz argue that rather than specific pieces of data, the commander requires information that is "highly variable and human-intensive."[19] They note that many studies have been conducted with the purpose of enumerating and prioritizing the commanders' information requirements. Because of the dependence of requirements on the situation and the complexity of warfare at the operational level,[20] Kahan concludes that "it is impossible to prioritize commanders' information needs *a priori and abstractly*."[Emphasis in original][21] He argues that central to commanders' information requirements is the commander's image of the battlespace. This image has several components: the current situation, the past (history), the future (options and consequences), "military" (concrete) and "psychological" (abstract). For this paper, the commander's image *explicitly* includes a representation of the traditional Commander's Intent. The commander and staff must seek information to maintain and validate the image; *the image defines the information needs*. This is a critical concept for the development of NCW.

Each commander will build his image differently and will constantly reorganize and refocus that image as situations develop. The goal of sharing the commander's image is to generate shared awareness of the battlespace throughout a fighting force. Because different people may visualize reality differently, sharing the commander's image is an imprecise activity. In order to ensure that differing images result in shared awareness of the battlespace, it is critical for each image to have the greatest possible correlation to reality. This shared awareness requires not just communication from the commander to the subordinate, but confirmation that the image is understood, and that the subordinate is prepared to act appropriately on the image. Validation of the image includes spot-checking both the image and subordinates' understanding of the image. Both of these activities may require the commander to ask questions at a level of detail below the operational.[22,23] The Operational Commander requires a staff organization and tools to maintain a dynamic image of the battlespace, validate the image, and communicate the image (generate shared awareness).

How does information flow to the commander? Kahan outlines three modes of information exchange: pipeline, alarm, and tree.[24] Pipeline flow is appropriate when the commander knows he will require a certain piece of information at a certain time; the staff is structured to provide these updates with a certain periodicity.[25] While this mode carries the advantage of predictability, the disadvantage is timeliness. Alarms are event-driven exchanges designed to notify a commander of departures (either positive or negative) from the plan. Alarms indicate that some part of the commander's image is no longer valid, and therefore notify a commander of a possible need to modify his planning or execution. While alarms have the advantage of timeliness, the disadvantage is the difficulty in anticipating the alarm conditions.[26] Both pipeline and alarm modes work well when the commander is not

questioning his image. Once information is received that causes the commander to question his image, he will normally go into tree mode, making inquiries of the staff and subordinate commanders to determine the extent to which his image is still valid, to analyze options for dealing with the unforeseen circumstance, and to rebuild shared awareness. While the answers to some of the queries the commander makes in tree mode may reside within his staff, often they result in queries down (and sometimes up) the chain of command. These additional queries result in undesirable layers of time-delay depending on where the information resides.

The three information exchange modes require two distinct methods of information transfer: pipeline and alarm require information to be pushed (supply-push) while tree requires information to be pulled (demand-pull).[27] Kahan concludes that information systems supporting the commander must support both supply-push and demand-pull modes of communication.[28] The Operational Commander requires a staff organization capable of dynamically managing supply-push information requirements and rapidly acquiring demand-pull information and a process to rapidly convey and adjust his information requirements. In this sense, the information requirements *become part of the commanders' image*.

With the vast volume of data and information flowing to the commander, there is always the potential for misunderstanding. Kahan outlines several reasons that the wrong information is conveyed. These include a misunderstanding of the image, difficulty in expressing uncertainty, focusing on the wrong level of detail, and information arriving late or at the wrong location.[29] The Operational Commander's staff must be adept at reducing misunderstanding of the image, clearly expressing uncertainty, focusing on the appropriate level of detail, and ensuring the timely availability of information at the correct node.[30]

Speed of Command: Operational Command and the OODA Loop.[31]

> *Machines don't fight wars. Terrain doesn't fight wars. Humans fight wars. You must get into the minds of humans. That's where the battles are won.*[32]
>
> Col. John R. Boyd, USAF (Ret)

There are various models for decision making processes in Command and Control. This paper will use the Boyd OODA Loop[33] as the basis of discussion, since the various models are all roughly analogous and the OODA Loop is the most familiar in the U.S. military. Figure 3 depicts the OODA Loop as conceived by Boyd.[34]

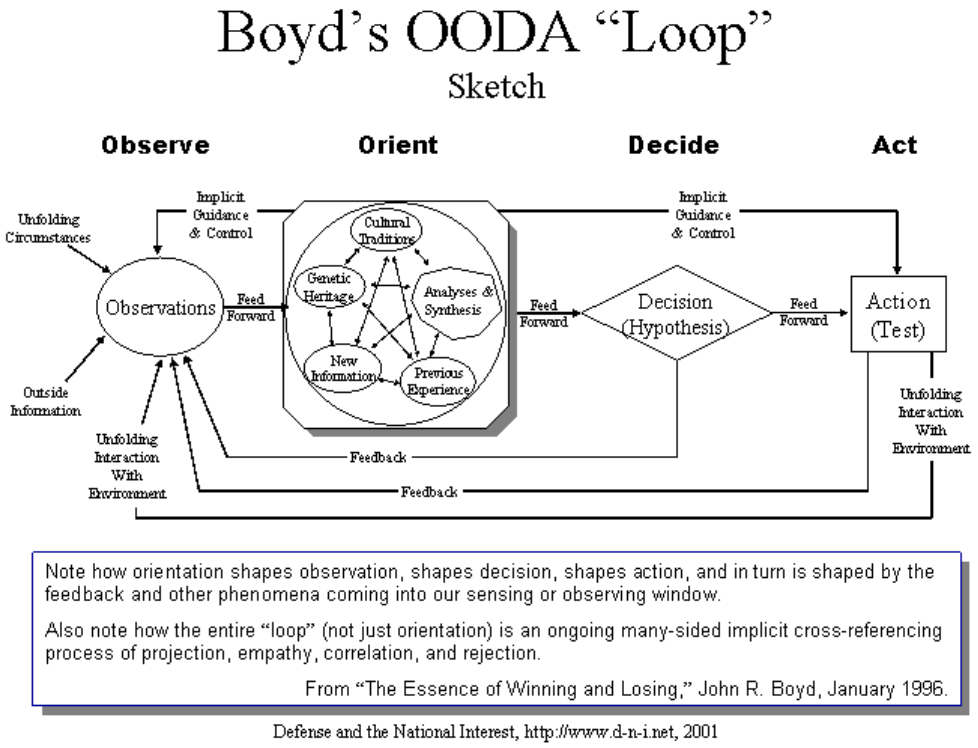

Figure 3

Boyd saw the OODA loop as a method of optimizing speed of action, with the goal of acting at a tempo that forces the enemy commander to continuously reorient. Doing so expands the friendly commander's options while narrowing the enemy commander's options. Boyd recognized that the loop is rarely executed sequentially; it is more often executed in

parallel, the orient and decide steps running continuously in the background and the observe and act steps being explicitly executed in the foreground. With well-crafted and communicated *mission-type* orders, explicit orientation and decision are required only when observations do not match expectations. Restated, the orient process is analogous to maintenance of the commander's image. The commander must reorient when he discovers that his image in not valid.[35] From these observations about the OODA Loop, several conclusions can be drawn.

- The Operational Commander and staff must be able to instantly understand and assimilate observations into the image.

- The Operational Commander and staff should be organized to make the limiting factor in OODA Loop execution the speed of action.

- The Operational Commander and staff should be able to rapidly reorient if the image is found to be invalid. When this is the case, the staff structure should make the limiting factor in the OODA Loop the speed of decision vice observation or orientation.

- The Operational Commander requires tools and processes that provide implicit, and when necessary explicit, guidance and control to both the "observe" elements and the "act" elements of the force. These tools and processes communicate intent and must therefore provide a near-instantaneous two-way communication and confirmation of understanding.

These requirements all have as their goal freeing the commander to focus on the future. By doing so, decision timelines during execution can be reduced to near zero.[36] The staff organization should provide the commander the greatest possible ability to focus on anticipation of future actions rather than supervision of current action.

This section has analyzed the requirements for effective operational command and control. Table 1 categorizes these into Core and Expanded requirements. Achieving the core requirements will provide the capability to then achieve the expanded requirements. Therefore, the remainder of this paper will focus on the core requirements.

Operational Commanders' Requirements of Command and Control System

Core requirements:

- maintain a dynamic image of the battlespace
- validate the image of the battlespace
- communicate the image (generate shared awareness)
- project situations into the future
- provide an analytical method for evaluating alternative COAs
- dynamically manage supply-push information requirements and rapidly acquire demand-pull information
- rapidly convey and adjust the commander's information requirements
- reduce misunderstanding of the image
- clearly express uncertainty
- focus on the appropriate level of detail
- support instant assimilation and understanding of observations into the commander's image
- communicate *intent* by providing near-instantaneous two-way communication and confirmation of understanding.

Expanded requirements:

- accommodate different styles of command
- support differing cognitive styles, but maintain the congruence with reality required to ensure that the images are consistent.
- make the limiting factor in OODA Loop execution the speed of *action*
- support rapid reorientation if his image is found to be invalid. In this case, the staff should be structured to make the limiting factor in the OODA Loop the speed of *decision* rather than observation or orientation.
- provide guidance and control to both the "observe" elements and the "act" elements of the force.
- provide the greatest possible ability to focus on anticipation of future actions rather than supervision of current action.

Table 1.

The Gap between Operational Commanders' Requirements and NCW Concepts and Development.

It can be argued that current systems and technology that are being touted as "network centric" do, to a limited degree, maintain a dynamic image of the battlespace.[37] They do not, however provide tools to develop all of the requisite components of the commander's image. Specifically lacking are the components of history, future projections, options and analysis, commander's intent, and abstract elements. Perhaps most importantly, current systems do not tell the commander what is *not currently known*. The image provided by current systems is unable to define the commander's information needs. Consequently, they can not generate and act on information requirements. They do not allow the commander to rapidly adjust his information priorities and communicate those priorities throughout the force. Further, the inability to describe where there are gaps in the image can create misunderstanding of the image.[38] Current systems do not express uncertainty well, which also contributes to misunderstanding. Nor do they have mechanisms for ensuring that the information in the database is understood.[39]

Current systems do not make significant steps toward validating the image. Data that can not be readily converted into information is handled poorly by both technology and staff.[40] Neither current nor proposed systems actively compare progress to plan, the vital first step in defining whether the commander needs to reorient and modify his image.

Current systems are designed to communicate their information across a network, generating a shared image of the battlespace. This communication is limited both by the inadequacies of the image and by the lack of a method of ensuring a common understanding at both ends of the communication path. It is further limited by technological challenges.

Current systems do not have a significant capability to project situations into the future, display alternative COAs, or provide an analytic method to evaluate COAs.[41] CNA has specifically noted that current tools are not able to provide the COA analysis required to consider and recommend alternatives.[42]

To an extent, current systems do offer tools designed to support differing cognitive styles. As an example, the AEGIS weapon system offers a tool set to customize (within strict constraints) the presentation of information.[43] A further key capability that AEGIS incorporates is an operator mode to function as a "knowledge manager" to control the display elements. Much more powerful tools and highly trained "knowledge managers" will be required to handle the volume of information available while avoiding information overload.

Most current systems rely nearly exclusively on supply-push information flow. Digital data links are examples of supply-push flow. Some strides are being made to create a demand-pull capability within systems available to the operational commander. An example is the K-Web.[44] Although a positive step, K-Web does not achieve the level of dynamic management of supply-push/demand-pull information flow that will be required.

Today's systems do not support instant understanding and assimilation of information into the image. This is largely a function of the highly dispersed set of non-interoperable sources from which the commander and his staff draw information. The result is that a large portion of the information flowing to the commander does so independently of context; the commander must provide context to the information. Logistics reports, intelligence estimates, and post-mission debriefs are examples of important sources of information that require manual conversion to knowledge. Furthermore, this conversion usually occurs in a

sequential, hierarchical fashion that, in attempting to distill the essentials, inevitably dilutes the quality of information and delays its transmission to the commander.[45]

Current battle management systems do not provide a clear, concise method for the commander to communicate intent. Communication of intent as part of the commander's image is critical to achieving self-synchronization. Future systems will recognize that self-synchronization requires shared awareness at the level of synchronization. [46,47] It is important to recognize that the sharing of the image goes not only down the chain of command, but up it as well, allowing the higher echelon commanders to verify that the actions of subordinates are within their intent, to analyze the impact of self-synchronization on supporting forces and logistics and adjust where necessary. This is not a new concept, but closely tracks the old "two up, two down" rule.

Will the current Combatant Command staff structure support the Commander's requirements for exercising command and control of the netted force of the future?

There are two distinct subordinate organizations to the Combatant Commander. The first organizes the primary advisors to the commander by service component. The commander may additionally decide to designate functional commanders.[48] Additionally, the Combatant Commander has a permanent staff, depicted in Figure 4. Their specific responsibilities are defined in Joint Pub 0-2, Unified Action Armed Forces (UNAAF).

Neither the functional component commanders nor the joint staff organizations supporting the Operational Commander are sufficient to execute these NCW concepts. The stovepiped nature of the organization necessarily results in delays which will become (if they aren't already) unacceptable to optimizing the OODA loop to maximize speed of action. A significant body of current research has highlighted the seams between the functional

commanders, especially between JFACC and JFLCC, and between JFACC and JFMCC. The seams are largely a result of a lack of a common image.[49]

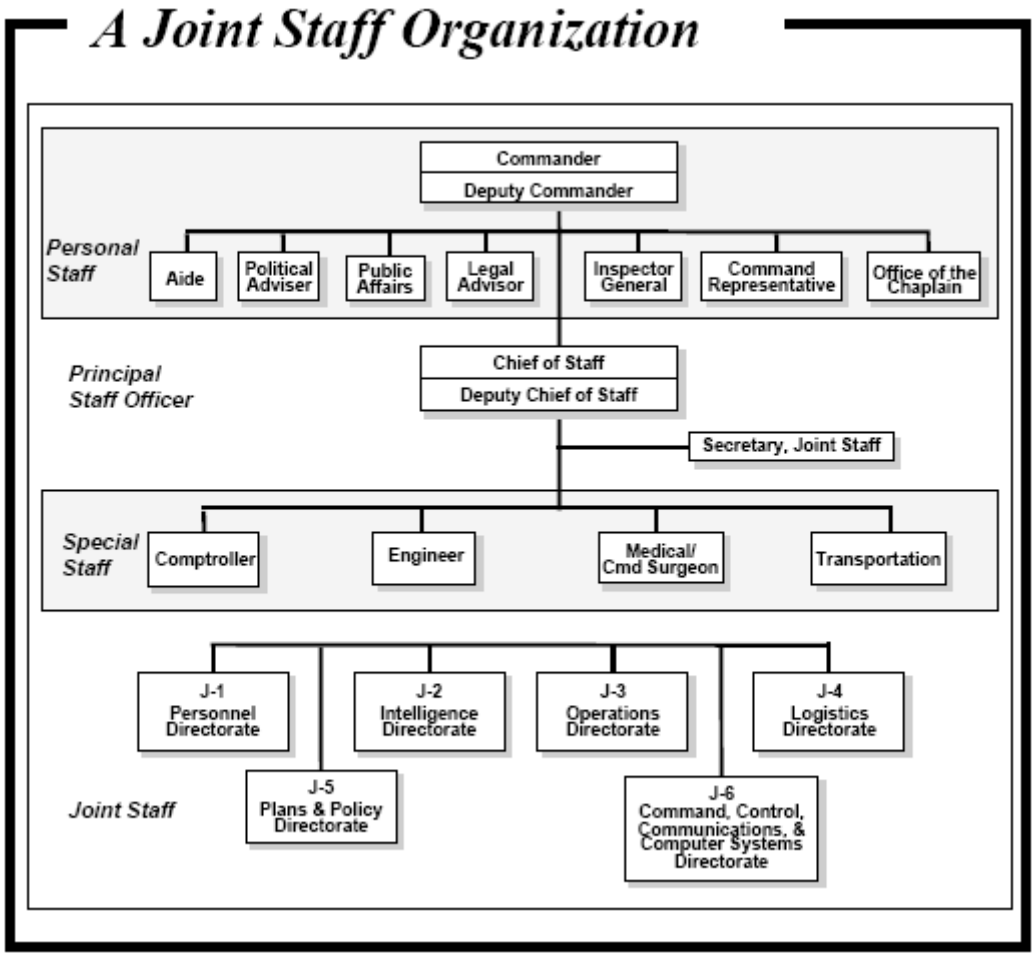

Figure 4[50]

Similarly, seams exist within the joint staff structure. The distinction between the J-33 and J-35 organizations results in a significant seam between planning and execution. The time required for J-35 to orient to current situations delays planning, while the time required for the current operations division to become familiar with the plans they are tasked to execute delays execution. Planning deadlines must account for the time required for J-33 and subordinate commands to orient to the plan. In practice, this results in a decoupling of planning from execution. [51] Neither the functional component commander organization nor

the joint staff organizations support the functional requirements of the Operational Commander in ONCW. Furthermore, given the large-scale tactical tools currently envisioned, it is easy to conclude that the staff structure will evolve toward a staff adept at managing large tactical systems.

The gap between the requirements of the commander and the capabilities of current and proposed NCW systems described above can be broken into two main categories: technological and human factors.[52] The following recommendations will focus primarily on co-evolution of the Operational Commander's staff organization to support ONCW.

Recommendations: Operational Network Centric Warfare.

> *The task at hand is to… leverage shared battlespace awareness to allocate, assign, and employ assets and then modify these allocations, assignments, and employments as awareness of the situation changes.*[53]
>
> Alberts, Garstka, and Stein

ONCW Technology: A Brief Summary.

While it is not the focus of this paper to conduct a detailed examination of technological development of ONCW,[54] a few foundational elements are required to place the organization recommendations that follow in a firm context.

To support the requirements in Table 1, four broad categories of technological improvement are necessary: information display, battlespace entities (Intelligent Agents, virtual organizations, virtual collaboration), interconnections, and an overarching architecture to ensure interoperability. Information display systems of ONCW will have the characteristic of presenting the commander's image according to the three dimensions of accuracy, relevance, and timeliness. Following this design principle ensures that the information provided to each decision maker is presented in the correct context for that decision maker. It also mitigates the need to provide all information at all nodes. Battlespace entities, whether

automated, human, or a combination of the two, will *act directly on the commander's image*, based on the context required of their function. These interactions will take three basic forms: image maintenance, image validation, and image communication. Network interconnections will support the display function and the battlespace entities by ensuring that data and information are routed as required by the image (remembering that the image defines the information needs). Finally, as a practical matter, an overarching architecture, consisting of standards and protocols, is required to ensure interoperability and to ensure that data and information generated by vastly different sources maintains the vital congruence with reality.

ONCW Command and Control.

In the framework of ONCW, the commander's staff, subordinate commanders, supporting organizations, and virtual organizations can all be viewed in network terms as either nodes or subnets, depending on composition, performing functions as battlespace entities. Alberts and Rutlin stress that there must be a co-evolutionary approach to NCW that incorporates not only technological change, but evolution of doctrine and command structure as well.[55] This section makes recommendations specific to the commander's staff to support the evolution of ONCW.

To recommend a staff organization that takes best advantage of NCW technologies, two entering arguments must be fixed, based on the conclusions above. First, command by influence (mission-oriented command) is the most likely to be successful. That is, netted warfare will be most effective when small units innovate and self-synchronize within the framework of a clear and well-communicated commander's intent (as part of the commander's image). Second, the overarching goal of ONCW is to increase the tempo of

operations by optimizing the Operational Commander's ability to generate speed of action by optimizing his OODA loop.

The proposed organization for the Operational Commander's staff is functional in nature and rests on the foundation of the commander's image. Within these constraints, there are two broad options for a functional reorganization to support the maintenance, validation, and communication of the commander's image. The first option is a moderate change to current organizational structures. In this proposal, each of the primary functions of the staff is redefined in terms of image maintenance, image validation, and image communication. For example, the J-2, J-3, J-4, J-5, and J-6 staffs would, at the macro level, retain their current functional areas of responsibility,[56] but each would be functionally organized into three main divisions: image maintenance, image validation, and image communication.[57] This proposal has two major inherent weaknesses. First, while it focuses the joint staff's efforts in a more "network centric" way, it preserves to large degree the inherent weaknesses and stovepipes in the current system. Second, it does nothing to address the difficulties with the functional component commander concept discussed above.

A more comprehensive reorganization would see the staff reorganized to correspond to the major network centric tasks that contribute to the commander's image: image maintenance, image validation, and image communication. Figure 5 illustrates how the three tasks contribute to the commander's image.

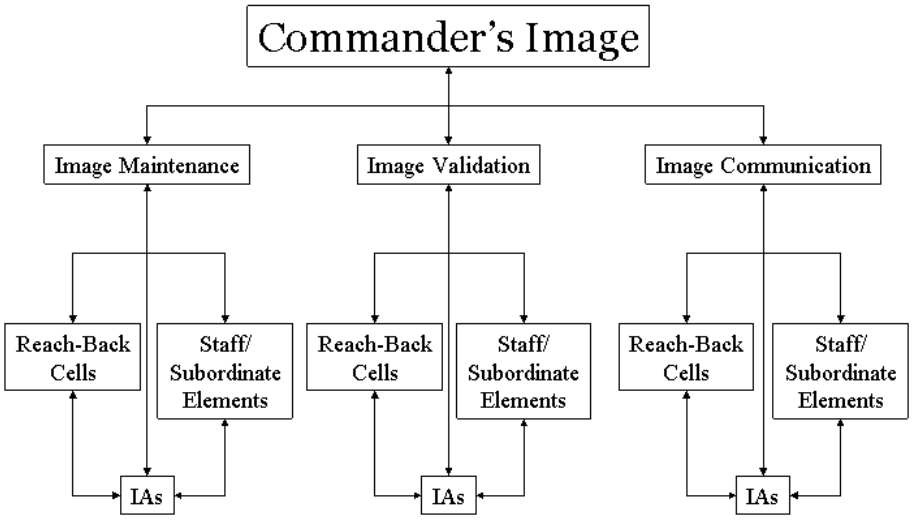

Figure 5: Image-Based Tasks

Major staff directorates corresponding to Image Maintenance, Image Validation, and Image Communication would be created (See figure 6).

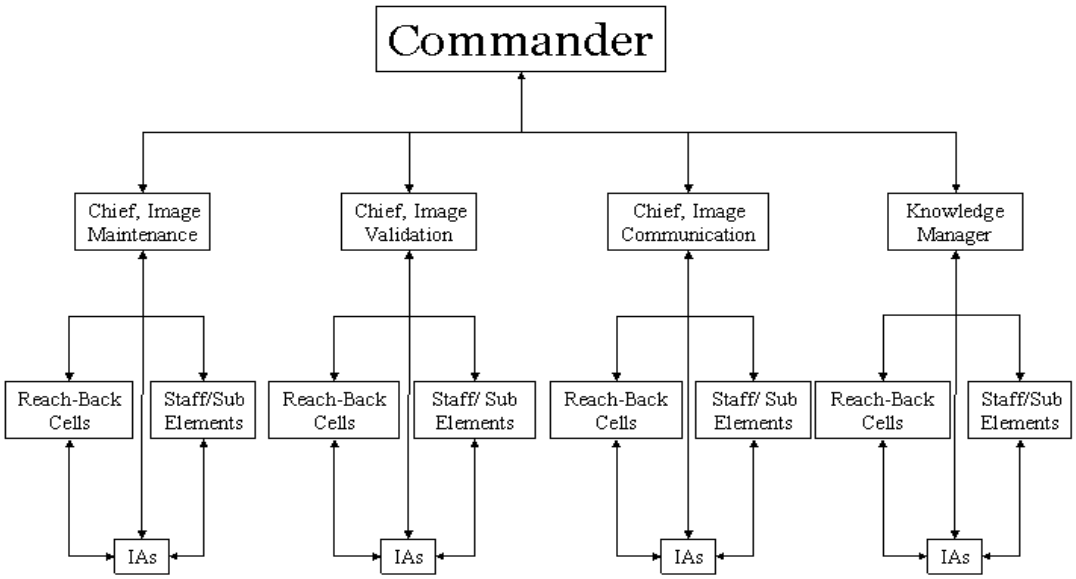

Figure 6: Proposed Staff Structure

This organization would require distribution of personnel with similar specialties across all three directorates, although the focus of each would be different. Image Maintenance would focus on collection and integration of information into the image (including planning and

COA evaluation), whereas Image Validation is envisioned as more analyst-oriented, to root out inconsistencies in the data and to act as Red during COA Analysis and wargaming, for example. Image Communication is responsible for ensuring the transition from image to shared awareness, and would be similar to a current operations watch center. Each directorate operates across the full spectrum of the battlespace, both in space and time. The Knowledge Manager maintains the staff's networks, network interface with the Global Information Grid (GIG), displays, and assists in algorithm development and modification for IAs. This is a logical extension of the J-6. The additional core requirements of Table 1 are provided by battlespace entities within these four major directorates.[58]

With regard to the functional commanders, the method of engagement (JFACC, JFLCC, JFMCC, JSOC) in network centric operations is less important than the effect (kill, disable, degrade). This leads to a departure from the current organization, centered on medium and method, to one centered on effect. Functional commanders tasked with sensing (Joint Force ISR and Sensor Commander (JFIC)), acting (Joint Force Effects Commander (JFEC)), and communicating (Joint Force C2 Commander (JFCC)) are proposed. The JFIC's responsibility is management and employment of sensors to meet the Commander's Image Maintenance and Validation requirements. The JFEC's responsibility is employment of hard- and soft-kill systems to generate effects specified in the image. The JFCC's responsibility is the management of the portions of the GIG available to the commander. This is closely aligned with the current sensor, shooter, and C2 grid vision of NCW, but acknowledges that not all effects are achieved by ordnance.

From an organizational standpoint, the second proposal has more merit. The staff organization supports the core network centric tasks of image maintenance, validation, and

communication.[59] Current seams related to geographic (forward and rear) and functional (JFACC, JFLCC, etc.) areas are eliminated, as is the seam between planning and execution. The latter is of special import: because the image contains past, present, and future, both planners and executors operate on the same image. Operating on the same image creates a natural dialogue across the time spectrum.

From a personnel management standpoint, this proposal is more difficult. Current service personnel and training methodologies roughly correspond to the current joint staff organization. The new organization requires similar specialists in each of the three divisions.

The recommended staff structure is designed to provide the Operational Commander the flexibility to benefit from self-synchronization as well as to take close control of forces when required by the mission. Implementation of this staff structure would be complex. Detailed definition of responsibilities and investigation of the feasibility and effectiveness of such an organization is an area for further research.

Conclusion.

> *To reach its full potential, Network Centric Warfare must be deeply rooted in Operational Art.*[60]
>
> David S. Alberts, et al.

Network Centric Warfare will not eliminate the need for Operational Art, but should instead be viewed as a tool to improve the Commander's ability to plan and execute complex operations. The current development direction of NCW does not support the Operational Commander's requirements to achieve this goal. NCW concepts, both technological and organizational, need to be shaped now to support the requirements of the Operational Commander. This paper has provided a starting point for discussion for the development of Operational Network Centric Warfare (ONCW) technology and staff organization. Further

research and positive action must be taken to develop this Operational Network Centric Warfare concept and translate it into fieldable systems.

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[1] Vego, Milan. *Operational Art*. (Unpublished Research Paper, U.S. Naval War College, Newport, RI: 1998), 148.
[2] The literature on this subject employs various forms of punctuation in the phrase "Network Centric Warfare." For the purpose of standardization, this paper will refer to Network Centric Warfare (NCW) unless directly quoting another work.
[3] Arthur K. Cebrowski and John J. Garstka. "Network-Centric Warfare: Its Origin and Future." *U.S. Naval Institute Proceedings*, 124, no. 1 (January 1998), 34.
[4] David S. Alberts, John J. Garstka, and Frederick P. Stein. *Network Centric Warfare: Developing and Leveraging Information Superiority*. (Washington, DC: C4ISR Cooperative Research Program Publication Series, 1999), 2.
[5] Cebrowski and Garstka, 31.
[6] Alberts, Garstka, and Stein, 7. From the point of view of the principles of war, Alberts, Garstka, and Stein recommend modifying only mass and maneuver in terms of effects-based operations.
[7] Ibid., 94.
[8] Ibid., 104.
[9] Ibid., 104-107.
[10] Cebrowski and Garstka, "Network-Centric Warfare: Its Origins and Future," 31. Considerable discussion in Cebrowski and Garstka and in Beard et al., "Network-Centric Warfare Battle Management: Framing the Issues." (Annotated Briefing. CAB 98-111/26. Alexandria, VA: Center for Naval Analyses, 1998) is devoted to this concept of COA lock-out and a high rate of change caused by massing of effects across the breadth and depth of the battlespace in order to invalidate the enemy's strategy. This theory can be viewed as a restatement of getting inside the enemy's OODA Loop, a concept which will be explored in the next section of this paper.
[11] For examples of recent sensor network experiments, see Alberts, Garstka, and Stein, 140-155.
[12] Ballard, John R., "Information Management Functions of Joint Command: *Six Enduring Keys to Mission Success in a Changing World Environment*." In *Command & Control Research & Technology Symposium:*

Naval War College June 29 – July 1, 1999, by the Department of Defense C4ISR Cooperative Research Program, Volume 1, 450-463. (Newport, RI: CCRP, 1999), 459.

[13] Joint Chiefs of Staff, *Doctrine for Joint* Operations, Joint Pub 3-0 (Washington, DC: 10 September 2001), II-3.

[14] This section draws heavily on Martin van Creveld, *Command in War* (New York: The Free Press, 1985); Carl H. Builder, Steven C. Banks, and Richard Nordin, *Command Concepts: A Theory Derived from the Practice of Command and Control* (Santa Monica, CA: RAND National Defense Research Institute, 1999); and Thomas J. Czerwinski, "Command and Control at the Crossroads," *Parameters*, Autumn 1996, 121-132.

[15] In *Command in War*, van Creveld states that while all methods or styles of command are responses to dealing with uncertainty and insufficient information, there are three basic methods of command: command by direction, by plan, and by influence. Czerwinski (122-124) argues that only command forms that distribute uncertainty (command by influence) are "likely to be… successful." This view of what makes a successful commander is reinforced in Builder when he concludes that the commander's ideas and ability to communicate them determine success to the degree that, if the command concept is sound and well communicated to subordinates, the commander can be completely absent during the operation, and the operation will succeed without him. Builder uses the term "command concept" rather than commander's ideas. This term's meaning is congruent with the term "commander's image" used in James P. Kahan, D. Robert Worley, and Cathleen Stasz, *Understanding Commanders' Information Needs* (Santa Monica, CA: RAND, 1989. Reissued with an introduction by General Gordon Sullivan, USA (Ret.)). R-3761. For consistency, this paper will use the term commander's image, or just image, to convey the meaning of the commander's image of the battlespace across time, historically, currently, and in the future. This includes not just distribution of forces, but also intent, plans, alternatives, and analysis of alternatives. An important distinction is that Builder does not state that the plan must foresee all possible circumstances, rather that if the commander's image is sound and well-communicated, subordinates will understand how to adapt to unforeseen circumstances in a way that supports the commander's intent.

[16] Builder, Bankes, and Nordin, 70-71, 87, 117-124.

[17] Czerwinski, 125.

[18] Kahan, Worley, and Stasz, 25-30.

[19] Much of the following sections is drawn from Kahan, Worley, and Stasz, 6-8; and Czerwinsky, 121-132.

[20] Kahan, Worley, and Stasz use the term Echelons Above Brigade (EAB).

[21] Kahan, Worley, and Stasz , 2-6.

[22] Ibid., 6-16.

[23] Czerwinski (125) reinforces these conclusions when he concludes that a command-by-influence system should be image-based, that the image itself should be transmitted rather than voice or text describing the image, and that it should further provide for "directed telescopes."

[24] This next section is drawn largely from Kahan, Worley, and Stasz, x-xiii, 24-30, 36-63.

[25] An example of a pipeline information flow is the commander's morning brief.

[26] It can be argued that the primary function of a current operations watch is to recognize and process alarm conditions.

[27] Kahan, Worley, and Stasz , x-xi.

[28] Ibid., 80-86.

[29] Ibid., 30-34.

[30] The requirements above apply to both the planning and execution functions of the Operational Commander. During both, the mental image must be built and shared awareness achieved. The primary difference is in the time available to adjust when the image is found to be invalid. In the planning phase, an invalid image may precipitate changes to the plan, while in the execution phase, an invalid image may require a command and control effort to adjust the execution of the plan and rebuild shared awareness, and may result in initiating further "crisis action" planning.

[31] The Observe-Orient-Decide-Act (OODA) Loop was conceived by Col. John R. Boyd, USAF over the course of several decades. The version presented here is from his unpublished January 1996 briefing, "The Essence of Winning and Losing."

[32] Col. John R. Boyd, quoted in Coram, Robert. *Boyd: The Fighter Pilot Who Changed the Art of War* (Boston: Little, Brown, and Company, 2002).

[33] Other models include the Lawson model (see J.S. Lawson, "Command and Control as a Process," *IEEE Control Systems Magazine*, March 1981, 5-12.), Wohl's SHOR Model (see J.G. Wohl, "Force Management

Decision Requirements for Air Force Tactical Command and Control," *IEEE Transactions on Systems, Man, and Cybernetics*, Vol. SMC-11, No. 9, September 1982, 625.) and the Headquarters Effectiveness Assessment Tool (HEAT) (see D. Serfaty, M. Athens, and R. Tenney, "Towards a Theory of Headquarters Effectiveness," in *Proceedings of the JDL BRG C3 Symposium*, Monterey, CA, June 1988.)

[34] The OODA loop is most often seen depicted simply as a loop with four arrows depicting an iterative process. Boyd recognized that feedback and feed-forward were critical elements of the command and control process and included as many as 33 arrows in his various depictions of the loop to reflect the interdependence of each element of the loop on the others. Too often on modern planning staffs, operating inside the enemy's OODA loop is taken to mean executing a faster four-step loop, i.e. a faster staff process. Boyd saw that the implicit guidance and control arrows were the key to operating at a faster tempo than the enemy, and accordingly championed mission-type orders and common understanding of intent.

[35] This is consistent with Builder and Czerwinski's conclusions.

[36] For an excellent discussion of putting this theory to practice, see Builder, 73-88, The Visionary: MacArthur at Inchon.

[37] For example, tactical systems such as Link 16 and CEC (and other data links) perform the functions of collating sensor data into information, the first step in building the commander's image.

[38] For example, if the user sees no enemy units in a geographic area, but it is unclear whether this is due to sensor coverage or is actually the case, uncertainty is created. This can cause the various consumers of the image to misunderstand it; some staff members or subordinate commanders may believe that there is no enemy in the sector, while others may believe that there may be enemy in the sector and additional sensors need to be dedicated to resolve the question.

[39] Tactical data links do not currently have a feedback mechanism that indicates that the picture was properly processed by the receiving system. Knowledge-Web (K-Web) is a networked solution for managing information across a staff and disbursed forces. This system has successfully deployed with the last several Navy Carrier Strike Groups (CSGs). K-Web allows indications that information was viewed, but not whether it was read, assimilated, or understood.

[40] From a technological viewpoint, there are three primary ways this can be accomplished. Information may be handled inaccurately by a system designed not to discard information. In this case, the system attempts to force information into a predesigned template, resulting in enormous inaccuracies. For example, when a Theater Ballistic Missile track enters a link architecture not designed for the speed and altitude parameters of those tracks. The data "wraps around" and the track jumps across the image. Data that can't be converted into information may be discarded, resulting in gaps (usually unknown to the operator) in the image. Or, it may cause an alert to an operator to resolve the conflict. Staffs also have a tendency to discard information that does not readily fit into the image. Absent a specific process (such as a manual fusion plot) to avoid this, important patterns and supporting information can be lost.

[41] Global Command and Control System has capabilities to present planning products, but lacks an analytical method of evaluating alternatives.

[42] Lyntis H. Beard et al., *Network Centric Warfare Battle Management: Framing the Issues* (Annotated Briefing. CAB 98-111/26. Alexandria, VA: Center for Naval Analyses, 1998).

[43] While many of these tools are designed to tailor display to mission priority (i.e. Air Defense vice ASW), some are designed to tailor display elements to the cognitive style of the operator. These tools include differing ways of indicating poor track quality, a flexible system of applying text tags to tracks, and a tool to customize overlays that may be slaved to tracks to provide quick reference to capabilities and limitations.

[44] K-Web is capable of notifying each user when information has changed and allowing the user to easily view changed or new items. This is a step in the right direction, but still relies (although less rigidly) on a predefined set of information that staff elements push to the K-Web. K-Web is also designed to dynamically push the new changes to servers distributed at different locations, including other ships of the battle group and servers ashore. This has proven successful at creating a greater degree of shared awareness throughout the CSG, especially on the commander's staff, as well as both up and down the chain of command. K-Web is limited however in that little of the information is real-time or near real-time. Additionally, much of the information consists of PowerPoint briefs and copies of record message traffic.

[45] Beard, et al. (34) recognized that this process needs to be faster and more robust.

[46] For an excellent discussion of the risks and benefits of self-synchronization, see Steven D. Hatter, "Self-Synchronization: Splendid Promise of Dangers Delusion." (Unpublished Research Paper. Newport, RI: U.S. Naval War College. 16 May 2000). Hatter provides as well a concise definition of self-synchronization in the

context of NCW: "Self-synchronization occurs when friendly war-fighting entities seek to exploit the power of networking by acting with initiative in real-time – outside of tradition command and control mechanisms – in order to leverage advantage, seize opportunity, or address unanticipated needs or deficiencies, as violent interaction in the battlespace unfolds."

[47] For example, for two squad leaders to synchronize their actions to set an ambush does not require shared awareness at the battalion level.

[48] These normally include the Joint Force Air Component Commander (JFACC), Joint Force Maritime Component Commander, (JFMCC), Joint Force Land Component Commander (JFLCC), and Joint Special Operations Commander (JSOTF).

[49] There are, of course, numerous contributing factors, including training, interoperability, and doctrinal differences as well.

[50] Joint Forces Staff College, *The Joint Staff Officer's Guide: 2000* (Norfolk, VA: National Defense University Press, 2000), 1-49.

[51] Alberts, Garstka, and Stein (180-185) recognized the same challenges, noting that the "current cyclic nature of command and control limits decision throughput, and the separation of planning from execution limits tempo."

[52] Technology can be subdivided into two main categories. The first is a lack of adequate information processing, display, and analysis tools. These tools deal with the flow of data and information, the processing data and information into knowledge that is part of the shared image of the battlespace, and management of information overload. This category includes the tools necessary to maintain, validate, and communicate the shared image, including intent. The second category is a lack of adequate planning tools. These tools deal with generation and analysis of options; wargaming, modeling, and simulation; paring of forces to objectives; and sequencing and synchronization. Central to both sub-categories is a quantum improvement in the design of user interfaces to efficiently present the information and prevent overload. (For further discussion of information overload see U.S. Naval War College, Global 99 Executive Summary (Draft), quoted in Fuller, John V. "Information Overload and the Operational Commander." (Unpublished Research Paper. Newport, RI: U.S. Naval War College. 8 Feb 2000),which noted that "Schemes are needed for prioritizing and displaying information to enhance the speed of understanding, and subsequent action by the warfighter.") Human factors can be subdivided into several sub-categories. Among these are organization, training, doctrine, personnel, and leadership. These categories are from John Garstka, "Implementation of Network Centric Warfare." *Transformation Trends*, 28 January 2004. Garstka expands on earlier writing on co-evolution of NCW, including now "Doctrine, Organization, Training, Material, Personnel, Leadership, and Facilities."

[53] Alberts, Garstka, and Stein, 115.

[54] Detailed technical recommendations are being developed in a separate work in progress.

[55] See Alberts, Garstka, and Stein; and Grant G. Rutlin, "The Digital CinC: Changing Command and Control Architectures for the Information Age." (Unpublished Research Paper. Newport, RI: U.S. Naval War College, 4 Feb 2002) for further reading. Alberts, Garstka, and Stein (4) acknowledge that the "entry fee" for NCW is the technology, which they term the "infostructure," but that this must be tied to concepts of operations, command and control approaches, organizational forms, doctrine, force structure, support services, etc. They term this combination a "Mission Capability Package." Rutlin envisions a phased co-evolutionary change in command structure to support the new capabilities of NCW, eventually flattening and then restructuring COCOM organizations along functional lines.

[56] J-1 would transition to the personal staff.

[57] For example, J-2 Image Maintenance (IM) would be responsible for integrating data and information from intelligence organizations into the commander's image. This would be accomplished through use of battlespace entities acting directly on the image. J-2 Image Validation (IV) would be task organized to root out inconsistencies in the image, raising alarm conditions, and provide feedback in the form of requests for information to resolve the inconsistencies. Likewise, J-2 Image Communications would be responsible for communicating the image to supporting organizations (both in theater and reach-back) and focusing their efforts to support the image.

[58] Specifically, battlespace entities (staff elements, IAs, virtual organizations) under Image Maintenance naturally work to project situations into the future, develop and evaluate alternative COAs, conveys information requirements, reduces misunderstanding, expresses uncertainty, and supports assimilation of observations into the image. Battlespace entities under Image Validation assist in COA development and evaluation, projection of

situations into the future, and adjusting information requirements. Image Communication performs the core requirements of communicating intent and focusing the force on the appropriate level of detail.

[59] There is nothing in the construction of the commander's image that is inherently "J-3" in nature, although it is currently within the J-3's scope of responsibility to lead the image maintenance effort. Rather, the image has components that are traditionally J-3 tasks (friendly force disposition and orders), J-2 tasks (JIPB and enemy disposition), J-4 tasks (logistics movement and planning), J-5 tasks (CES and future planning, COA analysis), and even vital components that are related to personal and special staff.

[60] Alberts, Garstka, Stein (3) further explain this statement as meaning the systems, doctrine, and organization must co-evolve to realize the full potential of NCW.